Annual DOE/Nuclear Physics Review of RHIC Science and Technology

ESSHQ

Edward T. Lessard
Collider-Accelerator Department

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Brookhaven Science Associates
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BROOKHAVEN NATIONAL LABORATORY

Outline

- ESSHQ Labor in NPP
- C-AD Example Organization
  - Hazards and Environmental Aspects
  - Waste streams
  - Costs
- Performance
- Arc Flash Event at STAR

NPP ESSHQ Labor (Direct and Allocated)

- C-AD: 9.4 direct; 8.8 allocated
- Physics: 1.75 direct; 0.5 allocated
- SMD: 0.7 direct; 0.5 allocated
- Instrumentation: 1.25 direct plus allocated

- C-AD will serve as an example in several of the slides

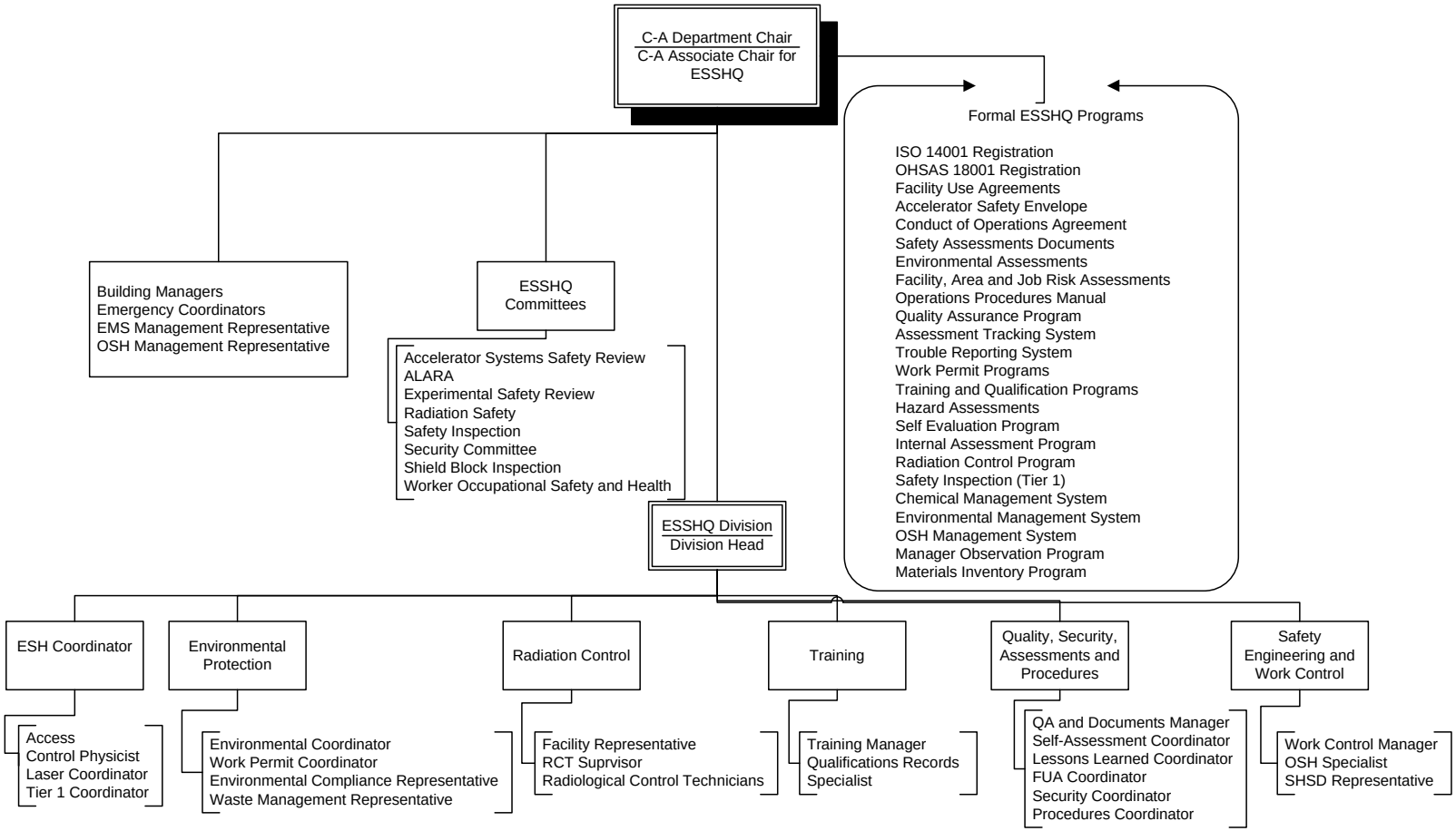
Summary of C-AD Facility Characteristics

- 7 accelerators
- 13 experimental areas
- 6.2 miles of vacuum pipe
- 24 miles of cable tray
- several thousand electro-magnets
- tens of compressors for the cryogenics systems
- 120 buildings
- 62 electrical substations
- 12 cooling towers
- 1.2 million ft^2 of office and laboratory space
- 1000 acres of land
- 1800 users
- 390 staff

Specific C-AD Facility Orders

- DOE O 420.2B, Safety of Accelerator Facilities
- DOE O 420.1A, Facility Safety
  - Natural Phenomenon and Fire Protection Sections only
- DOE O 414.1B, Quality Assurance
- DOE STD-1020-2002, Natural Phenomena Hazards Design And Evaluation Criteria For Department Of Energy Facilities
- DOE O 5480.19, Conduct of Operations

C-AD ESSHQ Operations



Summary of Environmental Aspects

- Regulated Industrial Waste
- Hazardous Waste
- Mixed Waste
- Radioactive Waste
- Atmospheric Discharges
- Liquid Discharges
- Storage/Use Of Chemicals or Radioactive Material
- Soil Activation
- Power and Water Consumption
- Sensitive/Endangered Species and Sensitive Habitats

Summary of Radiological Hazards

- Contamination at target and beam dump
- High residual-radiation levels at target areas
- Tritium production in helium gas and cooling water
- Radioactive waste
- Radioactive atmospheric discharges
- Radioactive liquid effluents
- Storage/use of radioactive material
- Soil activation
- Residual-radiation from activated materials
- Very high in-beam radiation levels
- Shield-shine
- Sky-shine

Summary of OSH Hazards

- Non-ionizing radiation (lasers, rf, UV)
- Working with hazardous or toxic materials
- Exposure to electrical energy
- Oxygen deficiency
- Confined spaces
- Kinetic energy (being struck by an object)
- Potential energy (falls, vacuum windows)
- Contact with temperature extremes

C-AD Waste Streams

LLRW	2000-3000 ft^3/yr	Non-compactable steel, aluminum, copper, resins, plastics, micarta. Compactable PPE.
Mixed Waste	30 ft^3/yr	Electronic components with lead solder, brass hose fittings, soldered copper and buss fittings.
Activated Liquids	1200 gal/yr	AC-500 cleaner, water, water with antifreeze, vacuum pump oils.
Hazardous Waste	1200 lbs/yr	Chemical lab pack, spray cans, epoxy, cleaners, etc.
Industrial and Hazardous Barreled Waste	25000-30000 lbs/yr	Oils, oily rags, spill cleanup dirt and soil, nonradioactive water with antifreeze.

C-AD ESSHQ FY04 Cost Summary

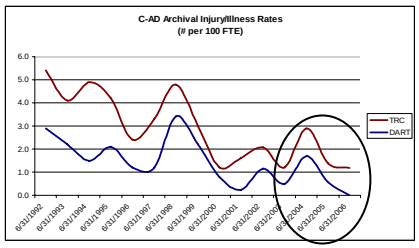
Category	FTE	Expense
■ Management Systems Maintenance	0.9	-
■ Pollution Prevention	-	$348,000
■ Waste Costs	-	$3,250,000
■ Fines/Violations	-	-
■ Injury/Illness	-	$82,050
■ Monitoring	0.2	$115,900
■ Backward-oriented measures	1.6	-
■ Future-oriented measures	2.2	-
■ Technical Support	14	-
■ Total	18.9	$3,795,950

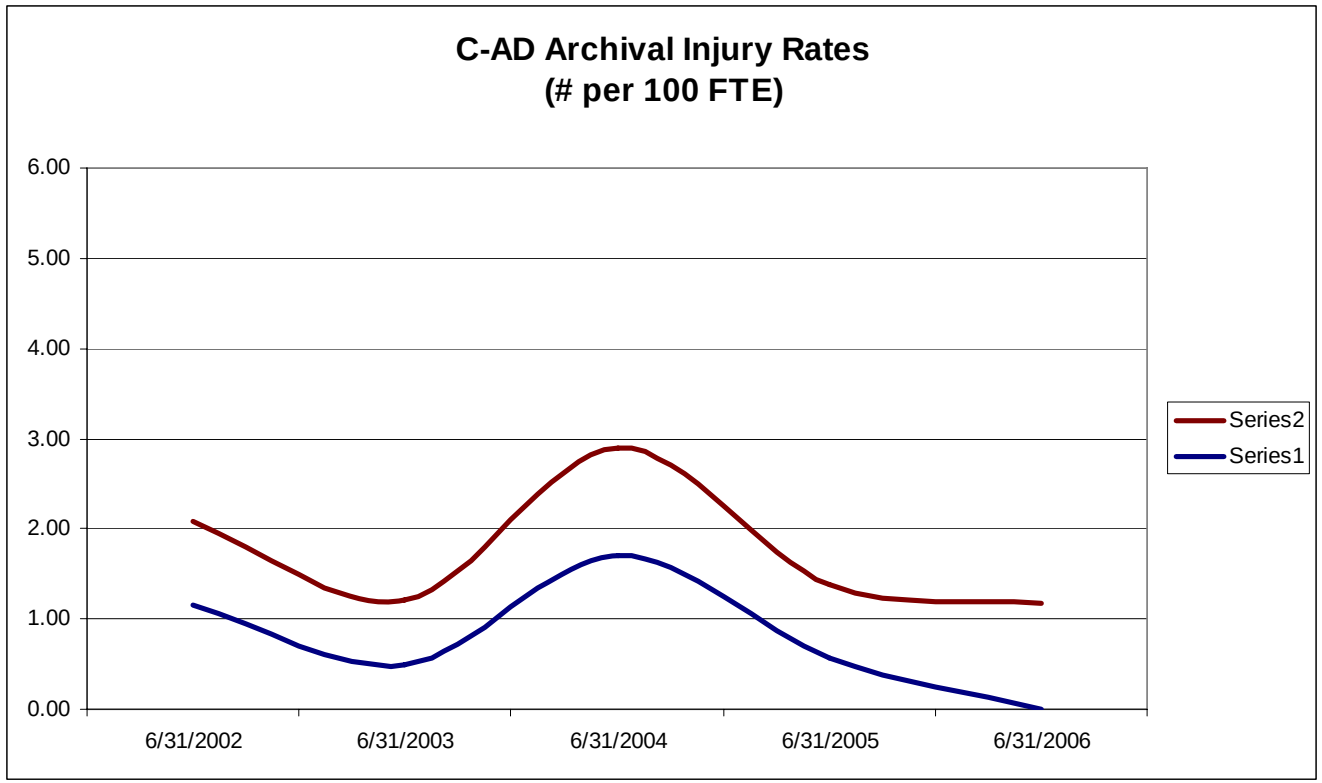
C-AD ESSHQ FY05 Cost Summary

Category	FTE	Expense
■ Management Systems Maintenance	0.7	-
■ Pollution Prevention and OSH PPE	-	$527,000
■ Waste Costs	-	$3,100,000
■ Fines/Violations	-	-
■ Injury/Illness	-	$25,000
■ Monitoring	0.2	$79,000
■ Backward-oriented measures	1.6	-
■ Future-oriented measures	1.7	-
■ Technical Support	14	-
■ Total	18.2	$3,731,000

C-AD Injury Rates

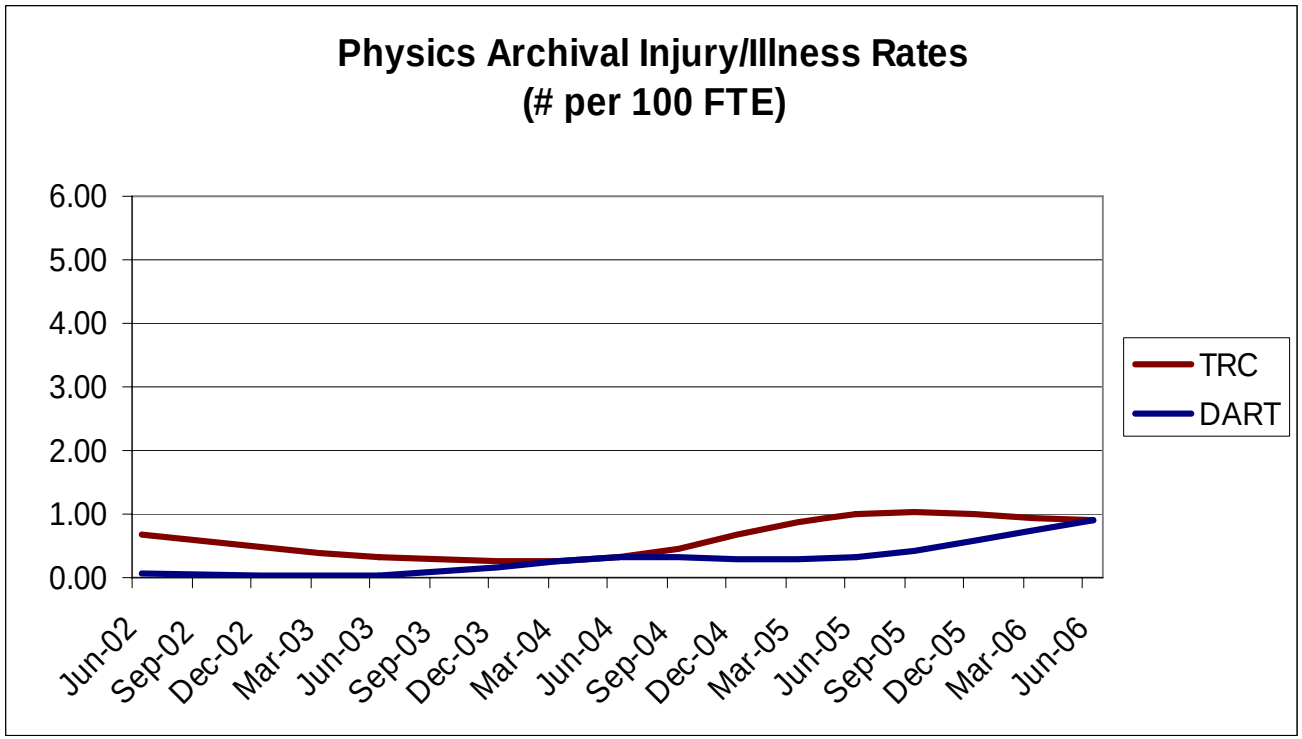
- FY06 DOE Expectation: DART <0.35 and TRC <0.87
- C-AD direct staff currently ~700,000 person-hours per year
- C-AD currently 570 days without a DART (~900,000 person-hours)





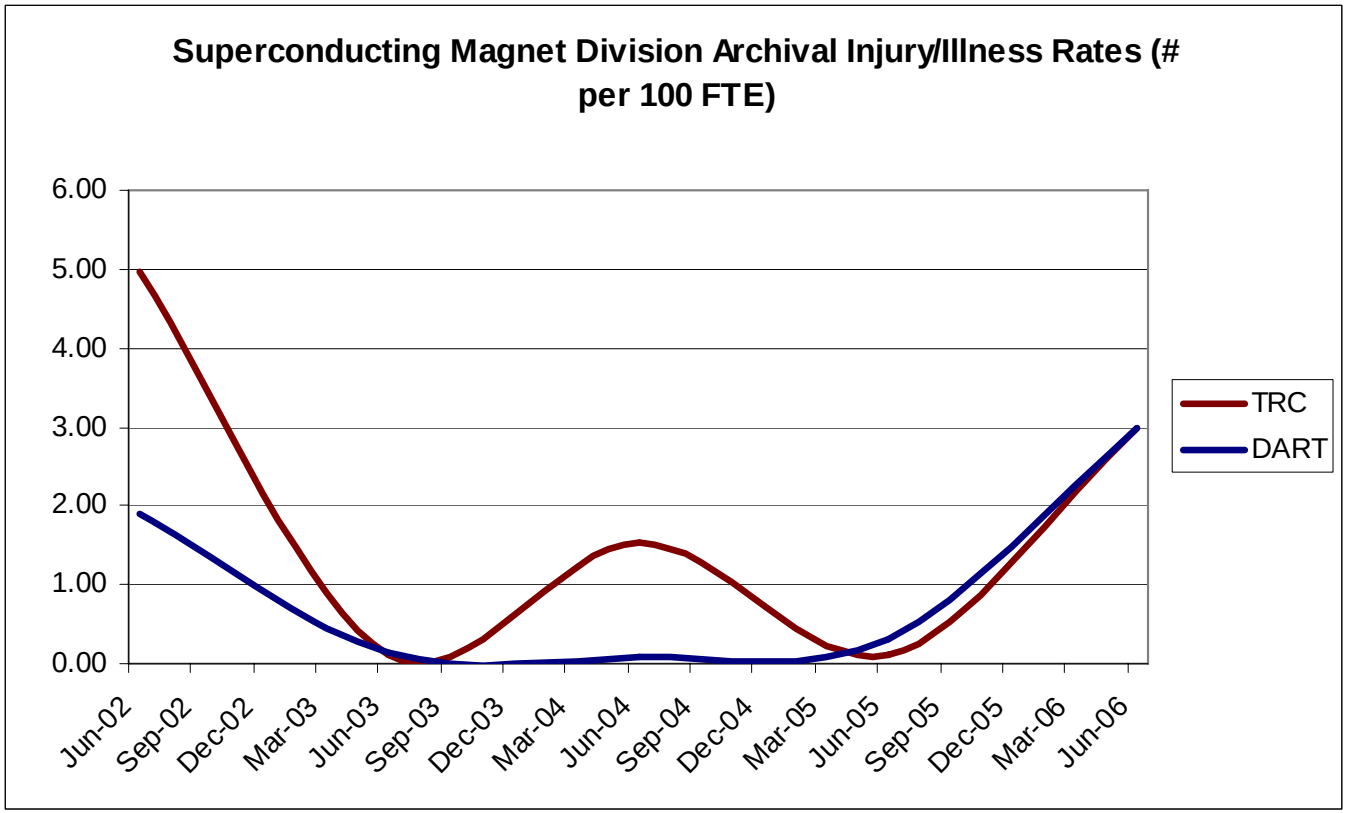
Physics Injury Rates

- FY06 DOE Expectation: DART <0.35 and TRC <0.87
- Physics direct staff currently ~540,000 person-hours per year



SMD Injury Rates

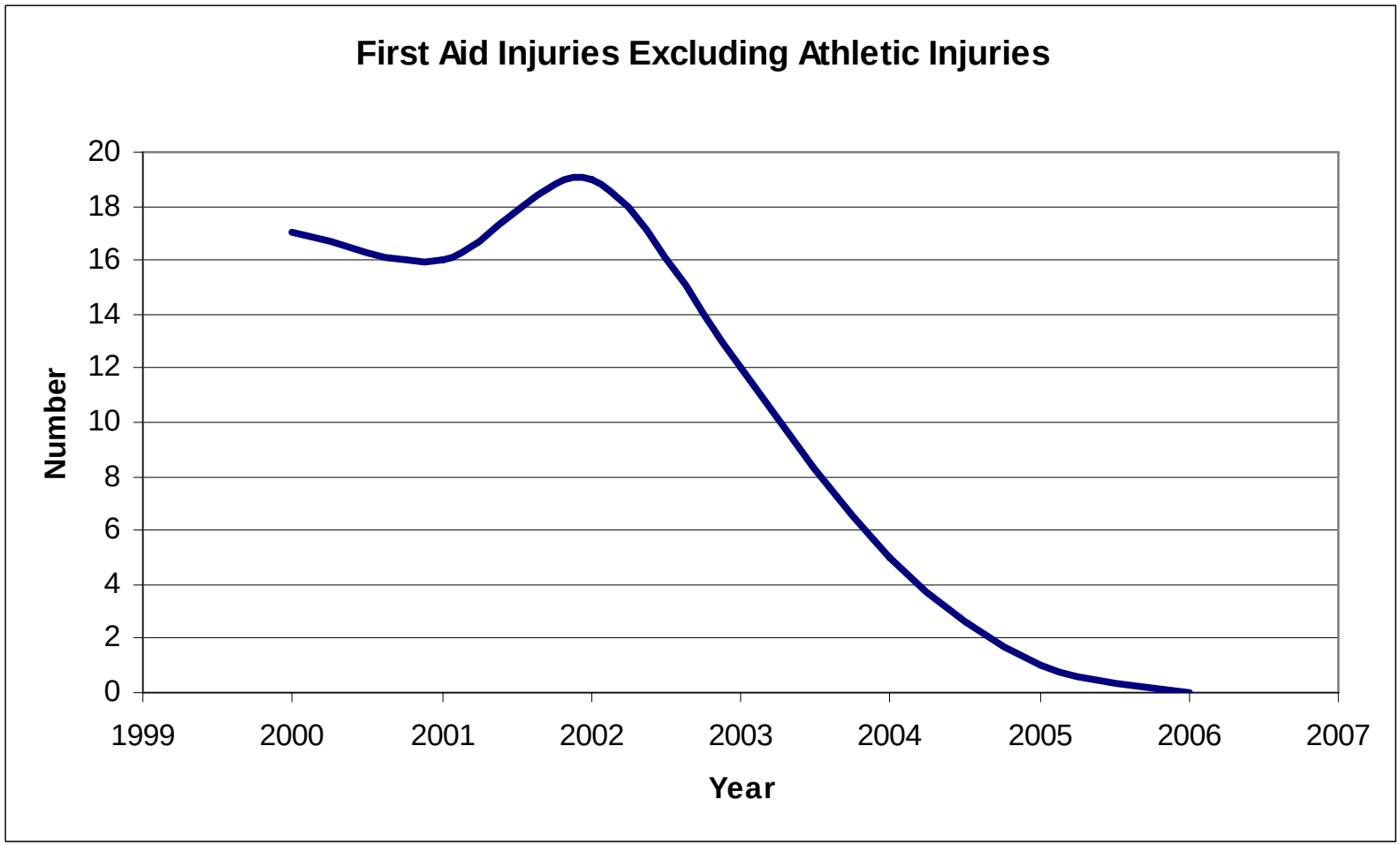
- FY06 DOE Expectation: DART <0.35 and TRC <0.87
- Magnet Division direct staff currently ~100,000 person-hours per year



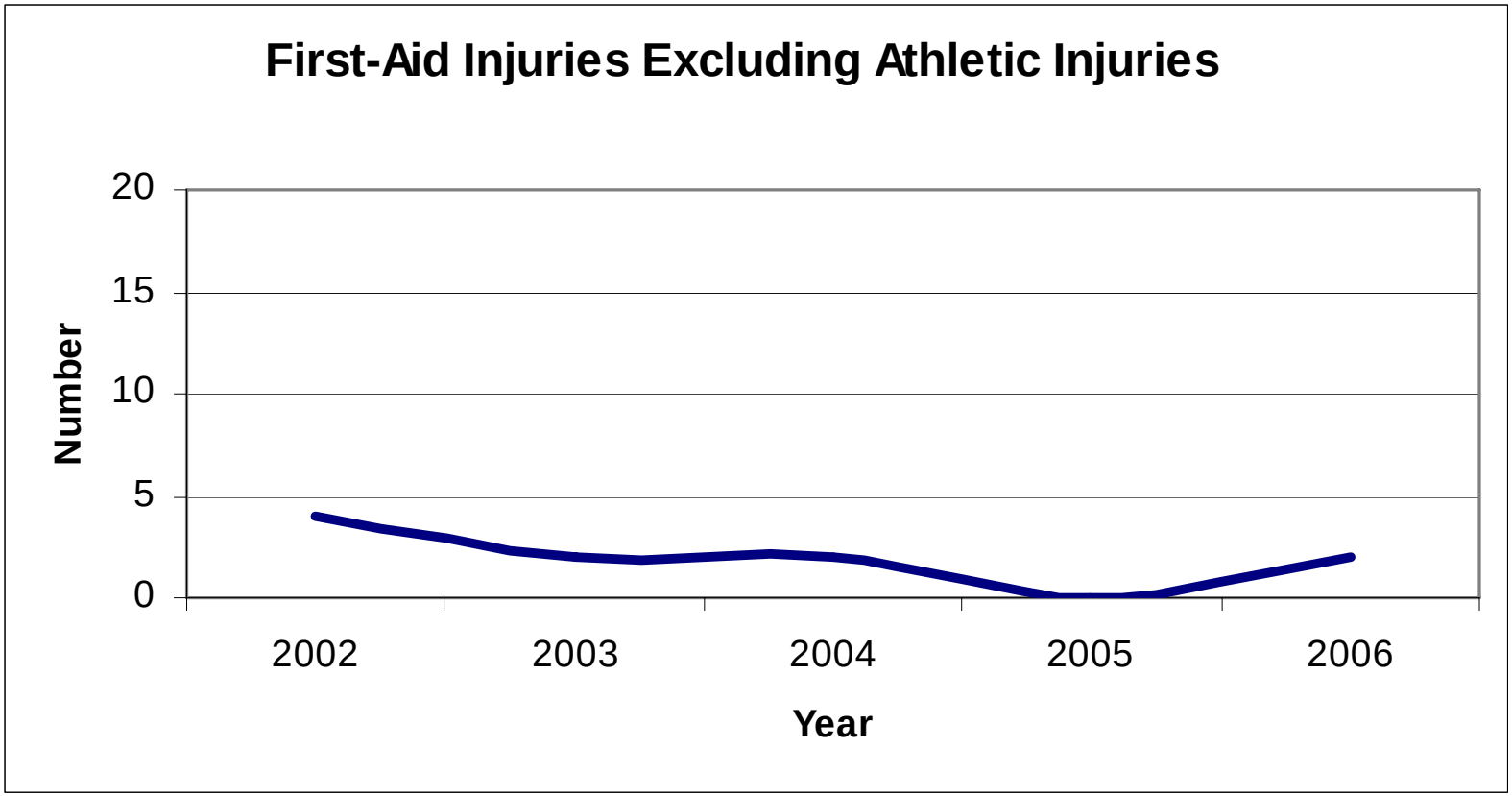
Instrumentation Division

- FY 2002 to present (~80,000 person-hours per year):
  - 0 DARTs
  - 0 Recordables
  - 0 First Aids

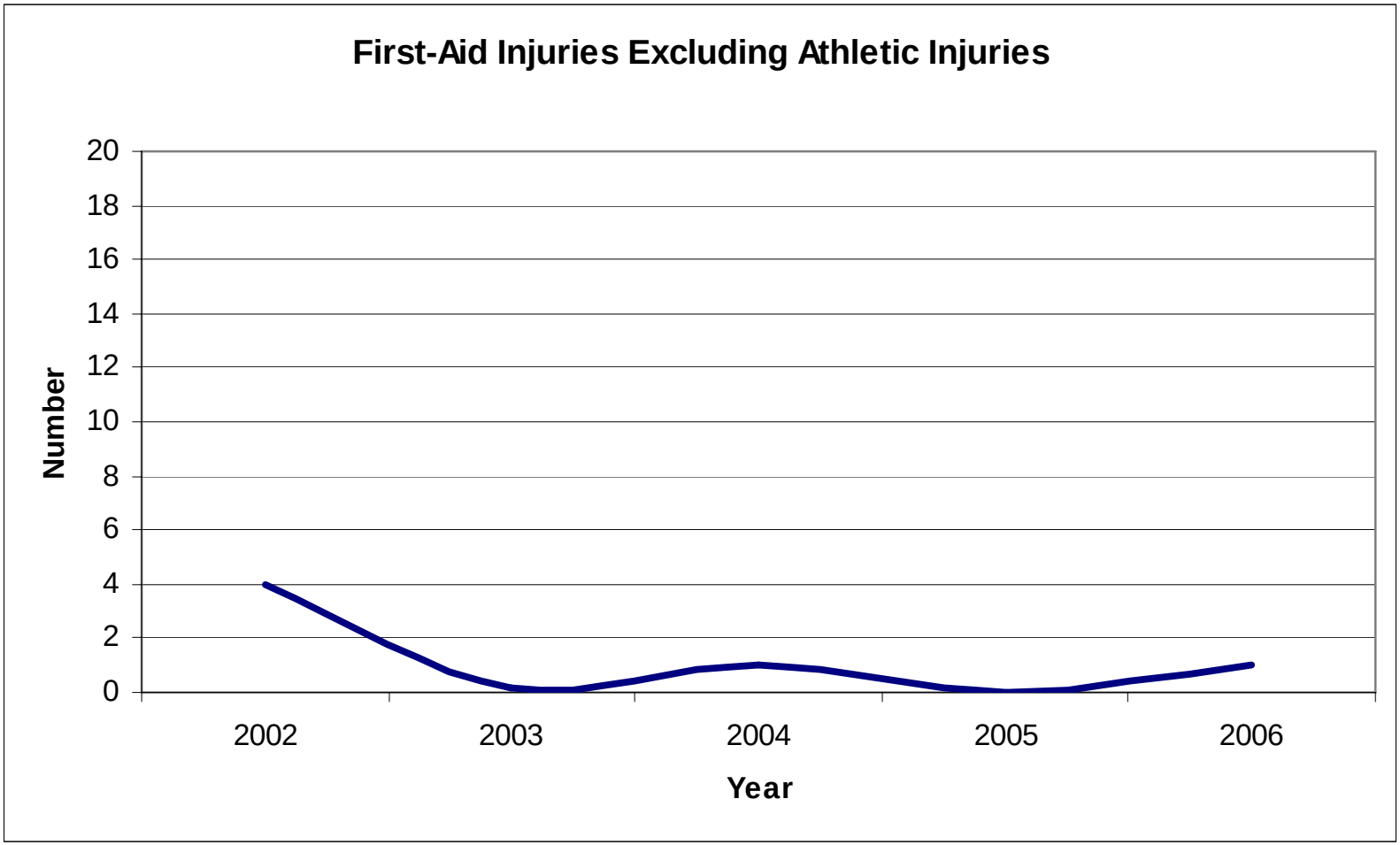
C-AD First-Aid Injuries



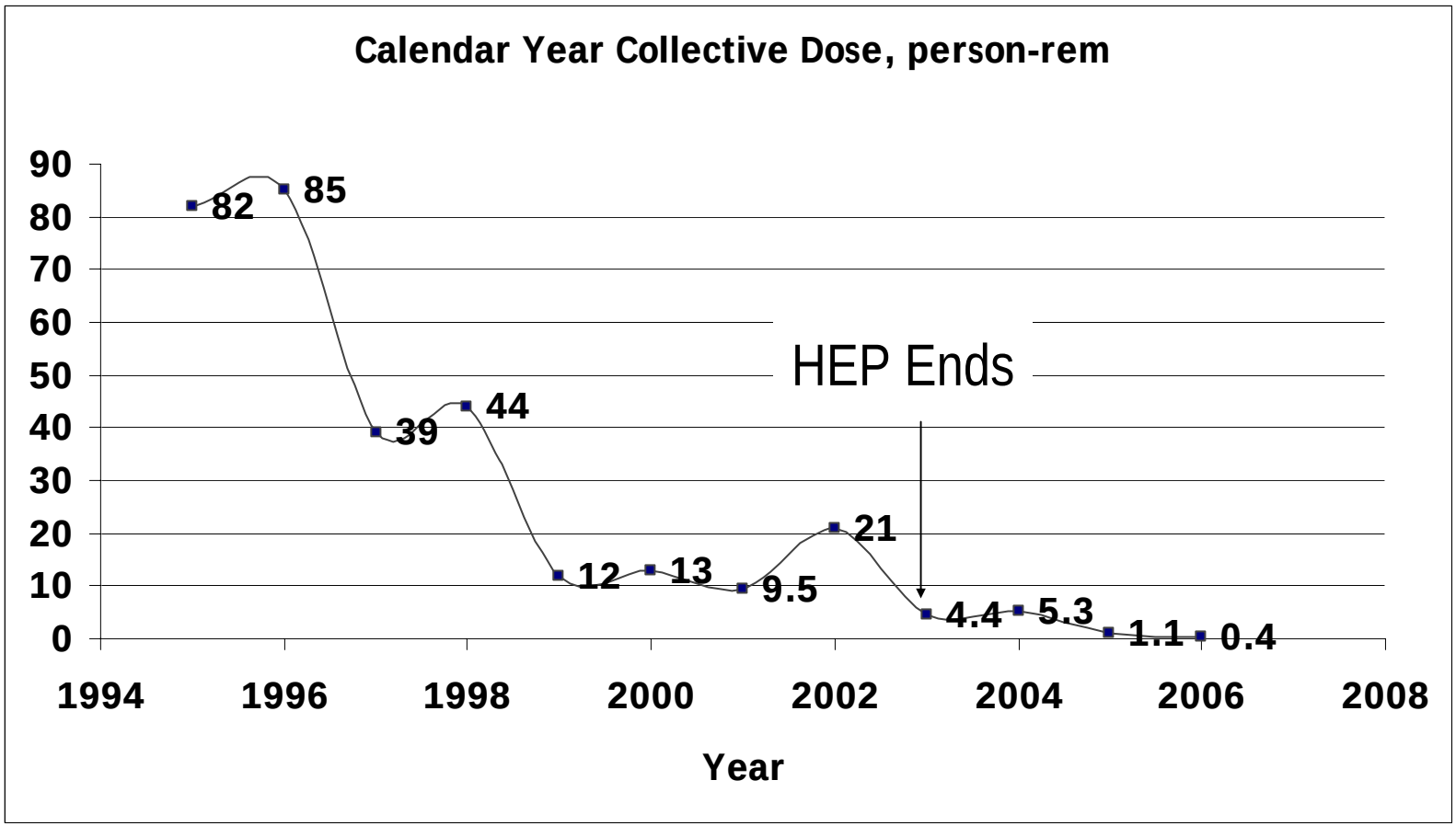
Physics First-Aid Injuries



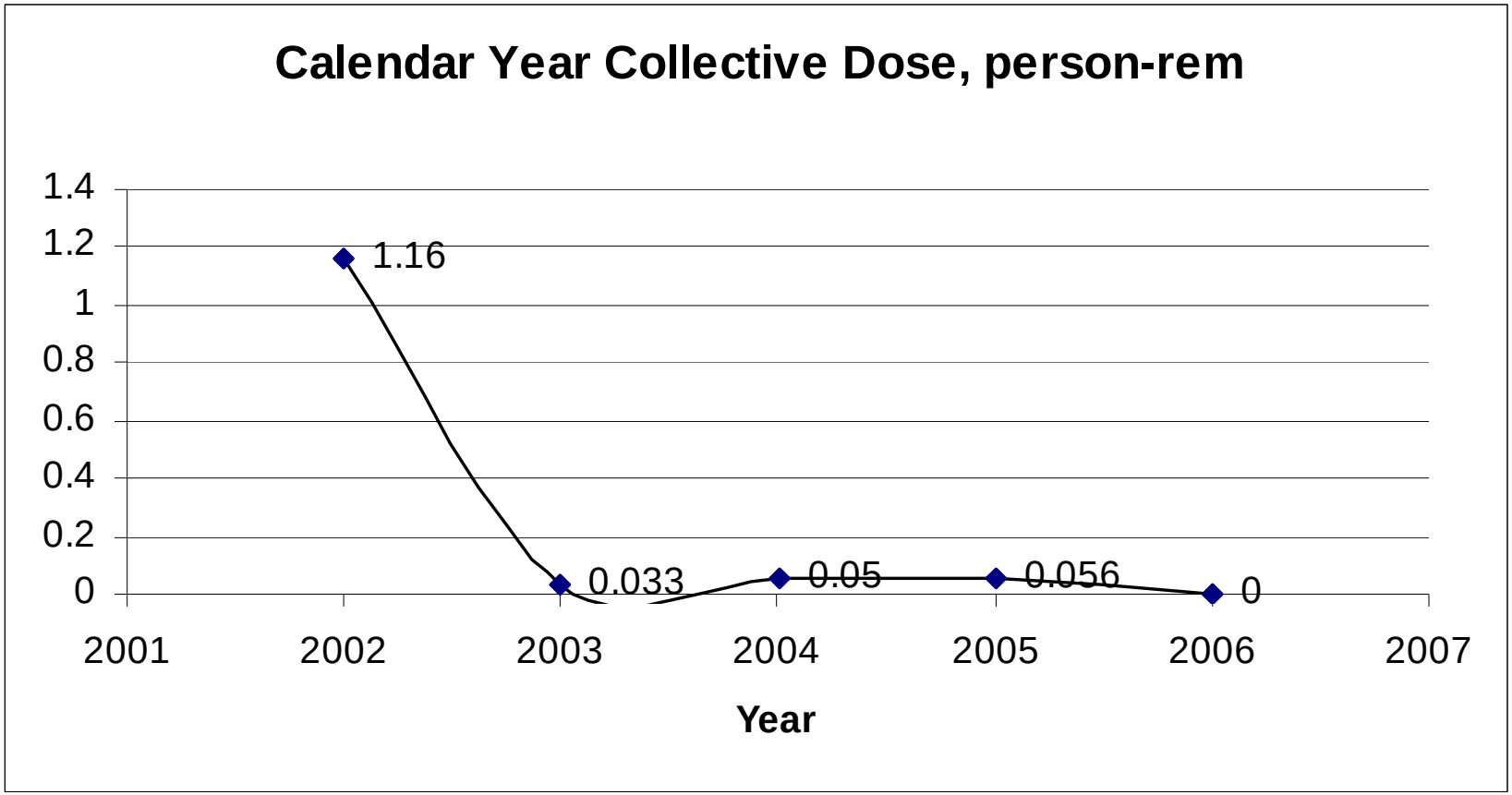
Magnet Division First-Aid Injuries



C-AD Radiation Dose Trend



Physics Radiation Dose Trend



Arc Flash Accident at STAR

- April 14, 2006 at ~1020
- Building 1006A Mechanical Loft
- Engineer operates 480 V 400 amp disconnect switch
- Arc flash injuries:
  - 1st degree burns to head, face, chest, and hands
  - 1st and 2nd degree burns to forearms
- Switch panel destroyed

Accident Scene

Summary

- Large facilities with complex hazards
- Potential for organizational accidents with multiple causes
- ESH performance approaching excellence
- ESH programs moving toward future oriented measures

Possible Causes for Arc Flash

- Switch failure
  - Pieces of switch mechanism falling across conductors
- High transient-voltage arcing-ground-fault on ungrounded delta system
- Foreign object
  - Open conduit stub may be source of foreign object

Accident Prevention Corrective Actions

- Replace GE 400 amp switches with Cutler-Hammer 400 amp switches
- Add auto-circuit breaker to STAR to remotely remove energy from switches
  - Switches can be operated de-energized
- Activate/install ground-fault detection systems with remote monitoring and alarms
- Measure sub-stations to determine if they can be resistively grounded
- Determine breaker settings at sub-stations and change trip levels as appropriate
- Perform arc flash calculations and label switches and CBs

Injury Prevention Corrective Actions

- Hazard Cat 2 PPE or greater for 480 V CB & switch operation
- Assure that PPE is worn properly through improved human performance training program